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LIFE HISTORY, MORPHOLOGY, AND TAXONOMY OF *ACUTALIS TARTAREA* (SAY) (HOMOPTERA: MEMBRACIDAE)[1]

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Abstract.—*Acutalis tartarea* (Say) is a membracid species found throughout the northeastern ⅔ of North America. We present information on its biology and field life history in Florida and draw comparisons with the biology of *Micrutalis malleifera* (Fowler).

A discussion of the polymorphic forms of *A. tartarea* is presented along with the reasoning for suppression of the names *Acutalis semicrema* (Say) and *Acutalis inornata* (Ball), both of which are color polymorphs. The immature stages of *A. tartarea* are described and illustrated.

Acutalis tartarea (Say) and closely related *Micrutalis* spp. were found in rotary flight traps near and on the undergrowths of coconut plantings during a study of homopterous insects associated with lethal yellowing (LY) disease of coconut palms in Florida (Tsai 1980). Simons and Coe (1958) found the treehopper *Micrutalis malleifera* (Fowler) to be the vector of pseudo-curly top virus (PCTV) in tomatoes grown in Florida. Their work provided the first documented record of a treehopper vector of a virus disease.

In light of Simons and Coe's work, *A. tartarea* was considered a possible vector of LY due to its proximity to diseased trees. Since little was known of its biology and life history the following study ensued. The purpose of this paper is to report on the life history, morphology, and taxonomic status of *A. tartarea*.

Materials and Methods

Since common ragweed (*Ambrosia artemisiifolia* L.) was found to be a natural host of *A. tartarea* in the field, it was the principal host plant in laboratory rearings. Seedlings were transplanted to styrofoam pots *ca.* 5 cm in diameter and held in a greenhouse equipped with an evaporative cooling system that maintained a temperature at *ca.* 27°C. Relative humidity was not controlled. China aster (*Callistephus chinensis* (L.) Nees), eggplant (*Solanum melongena* L.) and periwinkle (*Catharanthus roseus* (L.) G. Don) also were used for life history studies in the laboratory, under the same conditions as common ragweeds.

A. tartarea adults were collected in the Fort Lauderdale area to establish

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laboratory colonies. The stock colony of *A. tartarea* was reared on common ragweed in a rearing room at 24 ± 1°C and R.H. 75 ± 5%. Light intensities of 7,000 lux were provided by a bank of six fluorescent lights with a 12 hour photophase and 12 hour scotophase. The same conditions were provided for life cycle study.

In order to study nymphal development, host plants were modified by trimming the excess foliage from the terminal tips and placing these trimmed tips in rearing cages. Rearing cages consisted of 4.5 cm plastic petri dishes with their sides notched to accept the terminal stem of the host plant. The portion of the stems which passed through the notch in the petri dish was wrapped with sponge rubber to form a tight seal and prevent escapes. Dark colored paper was placed on the bottom of the dish to facilitate the observation of molted skins. Ventilation was provided by cutting a small hole in the petri dish lid and glueing a fine screen over it. Daily observations were made on each rearing cage throughout the duration of the study.

The morphological characters of each life stage were described and illustrated with the aid of a camera lucida mounted on a Wild® 5M dissecting microscope at 25× magnification. Measurements of nymphs in each instar were made with a Bausch and Lomb Zoom 7 Stereoscope® and a calibrated ocular micrometer.[2]

Results

Laboratory Life History Studies and Field Observations.—*A. tartarea* eggs hatch and the nymphs pass through 5 instars before moulting into the adult. Adult females generally lay eggs in clusters of 12–15 eggs each. These eggs are inserted into the epidermal tissue of the host plant which has been slit by the female ovipositor. Eggs are inserted to a depth that leaves *ca.* ⅓ of the egg exposed. Of the 82 plants examined, the favored oviposition sites were in the axis area of the leaf (70%) and the stem terminus (27%). Approximately 3% of the time, eggs were found completely exposed and held by the dense epidermal hairs of the host plant. On common ragweed, the number of eggs laid by a single female ranged from 12 to 62 and incubation time ranged from 10–23 days with a mean of 15.7 ± 3.2 (S.D.) days. On aster incubation time was significantly longer ($t = 2.72$, $df = 38$, $P = 0.01$) (see Table 1).

Early instar nymphs exhibit gregarious, sedentary behavior near the terminal portion of the ragweed plant. Early instars remain in the area of egg hatch and, as nymphal development progresses, later instar nymphs dis-

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[2] ® The use of a trademark name is not an endorsement of one product over another that is equally effective.

Table 1. Developmental time (in days) of *Acutalis tartarea* (Say) reared on common ragweed (*Ambrosia artemisiifolia* L.) and China aster (*Callistephus chinensis* (L.) Nees at 24 ± 1°C.

	Common ragweed				China Aster			
Life stage	Sample size	Mean	Range	S.D.	Sample size	Mean	Range	S.D.
Egg	24	15.7	10–23	±3.2	16	19.5	15–26	±3.1
1st Instar	22	4.5	3–8	±1.9	12	9.2	8–11	±0.9
2nd Instar	22	5.5	3–10	±1.5	11	9.6	7–12	±1.9
3rd Instar	22	4.5	3–7	±1.7	9	10.4	8–13	±1.6
4th Instar	17	6.6	4–11	±2.1	14*	12.0	10–15	±1.5
5th Instar	15	*12.1*	7–30	±3.1	13	*13.0*	10–16	±2.1
Total mean development time		49.9				73.7		
Adult longevity								
Female	14	12.1	3–45	±4.1	9	32.0	8–55	±6.4
Male	21	7.9	1–30	±3.1	7	20.0	7–31	±5.6

* Due to the increasing mortality, insects were supplemented by individuals from the colony reared on China aster. Their ages were determined on the basis of wing-pad development.

perse on the plant. Nymphal feeding occurs on the stems and petioles with individuals maintaining a head down stance. No feeding was observed on the leaves.

When reared on common ragweed, the mean nymphal development time for the 5 nymphal instars was 34.2 days at 24 ± 1°C (see Table 1). The mean time of nymphal development for instars 1 through 4 was between 4–6 days each and that for the 5th instar was about twice that of the earlier instars on common ragweed. Nymphs reared on aster have a longer developmental time (t = 2.62, df = 155, *P* = 0.01) (see Table 1).

Laboratory reared male and female adults live significantly longer (t = 2.73, df = 33, *P* = 0.01; t = 2.98, df = 14, *P* = 0.01 respectively) on China aster host than on common ragweed. On both hosts, female longevity is greater (t = 2.83, df = 21, *P* = 0.01; t = 2.78, df = 26, *P* = 0.01 respectively) than that of the male (see Table 1). Rearings were also attempted using eggplant (*Solanum melongena* L.) and periwinkle (*Catharanthus roseus* (L.) G. Don) but *A. tartarea* could not survive on either of these hosts.

Field observations substantiated egg cluster size, oviposition site selection, nymphal behavior and nymphal feeding orientation. Adult flight activity in the field occurred after 9:00 a.m., this seemed to be related to temperature and possibly light intensity. Greatest flight activity occurred during the warmest portions of the day. The most common field host of *A. tartarea* in Florida was common ragweed but the species was occasionally found on *Bidens bipinnata* L. (Spanish needles).

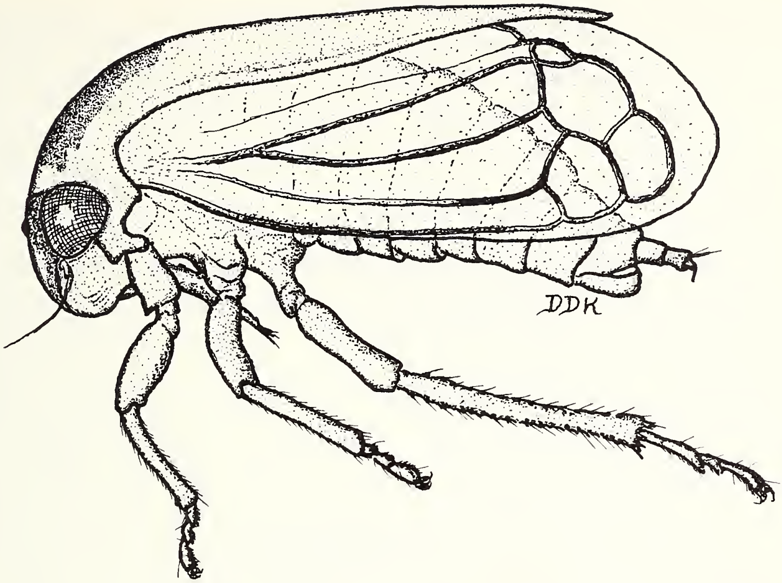

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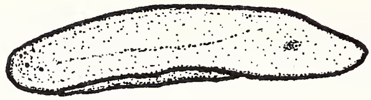
Fig. 1. Lateral view of adult male *Acutalis tartarea* (Say).

A monthly population survey was made from May 1978 to April 1979 by visually counting all *A. tartarea* on 35 ragweed plants randomly selected in the field (Fig. 8). The population was at very low levels from August through November. During this period the growth of ragweed in the field was greatly affected by environmental factors such as high temperature, dry months, and long day length.

Morphology

Adult.—The adult *A. tartarea* (Fig. 1) possesses the typical characteristics of Subfamily Smiliinae with its prothoracic tibiae not foliaceous, its metathoracic tarsi equal in size to the prothoracic and mesothoracic tarsi, three longitudinal veins in the tegmen arising near the base of the forewing and five apical cells present in the forewing. The head is twice as broad as long and the pronotum extends beyond the abdomen, but not covering the tegmen. The colors of the head, pronotum tegmen and legs vary from green to black. The adult female is 3.7 ± 0.07 mm (range: 3.5–3.9 mm) in length and 1.9 ± 0.00 mm (range: 1.8–1.9 mm) in width. The male is 3.3 ± 0.09 mm (range: 2.8–3.4 mm) long and 1.7 ± 0.03 mm (range: 1.5–1.9 mm) wide.

Since the immature stages of this species have not been previously de-



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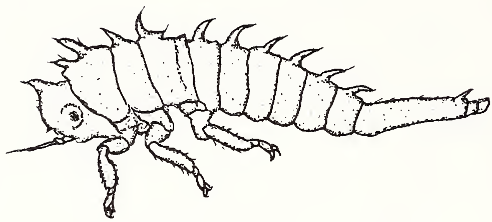

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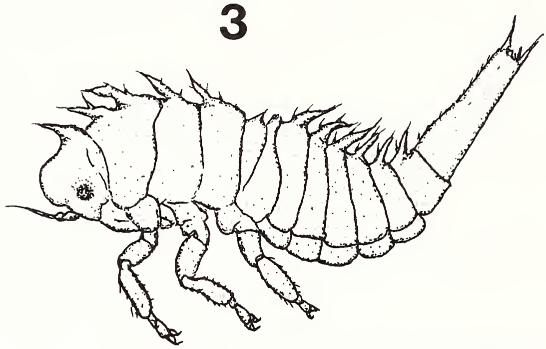

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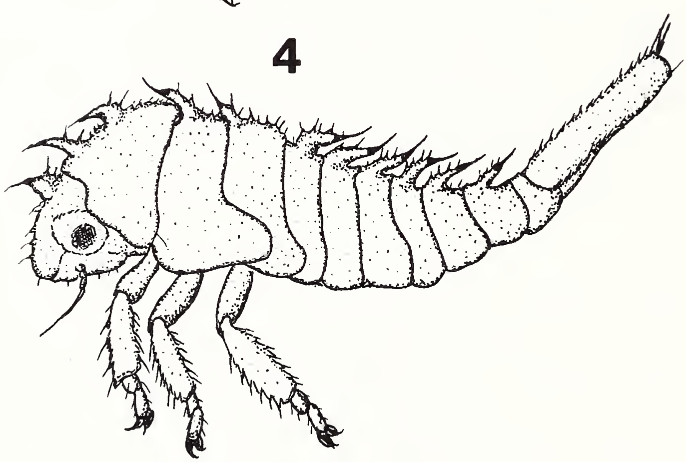

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Figs. 2–5. 2. Side view of egg of *Acutalis tartarea* (Say). 3. Lateral view of 1st instar nymph of *A. tartarea*. 4. Lateral view of 2nd instar nymph of *A. tartarea*. 5. Lateral view of 3rd instar nymph of *A. tartarea*.

scribed or illustrated in the literature, their description and measurements are presented below.

Egg (Fig. 2).—Mean length 1.0 ± 0.02 mm (range: 0.9–1.1 mm), width 0.3 ± 0.00 mm (range: 0.2–0.3 mm). Color white and translucent with one end blunt and the other end pointed.

First Instar (Fig. 3).—Mean length 1.4 ± 0.03 mm (range: 1.1–1.6 mm), width 0.3 ± 0.00 mm (range: 0.3–0.4 mm). Color pale green. Dorsum bearing well developed paired spines, 1 pair anterior projecting from vertex of head, 2 pair anterior projecting from dorsum of prothorax, 1 pair anterior projecting from dorsum of mesothorax. One posterior projecting pair from dorsum of metathorax and posterior projecting pairs from dorsum of abdominal segments 3, 4, 5, 6, 7, and 8.

Head: Clypeus triangular and hirsute; eyes prominent, projecting laterally, pigmented red. Vertex bearing 1 pair of well developed anterior projecting spines; rostrum projected caudad between prothoracic legs to metacoxae. Antenna located in front of eye, basal 3 segments enlarged and terminal segments filamentous.

Thorax: Dorsum of prothorax bearing 2 pairs of anterior projecting spines, one on either side of median line; 1 pair of anterior projecting spines on dorsum of mesothorax; 1 pair of posterior projecting spines on dorsum of metathorax. Pro, meso and metacoxae well developed; femora sparcely hirsute; pro and mesotibiae laterally compressed and expanded with setae on lateral edges; metatibiae ⅓ longer than pro and mesotibiae, only slightly compressed; tarsi 2 segmented, tarsal claws swollen at base.

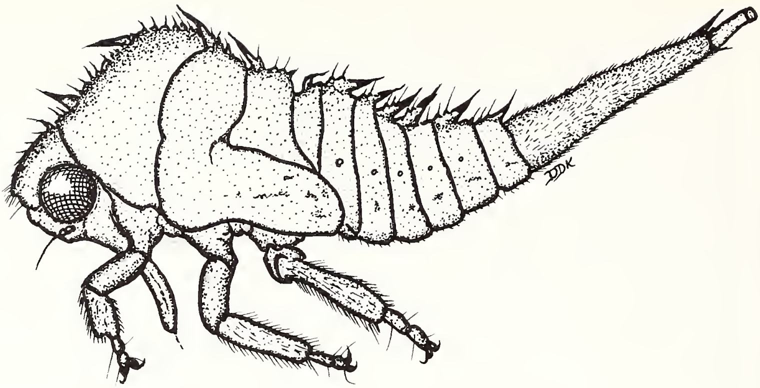
Abdomen: Dorsum of abdominal segments 1 and 2 unarmed, compressed against mesothorax, segments 3–8 each armed with a pair of posterior projecting dorsal spines, one on either side of median line; venter of segments 1–8 convex and with prominent setae; segment 9 elongate, tapering to apex, subequal in length to combined length of segments 5–8; segment 9 bearing a dorsal pair of posterior projecting spines, entire segment setaceous.

Second Instar (Fig. 4).—Outline and shape similar to previous instar, except in size. Mean length 1.8 ± 0.05 mm (range: 1.6–2.1 mm), width 0.5 ± 0.01 mm (range: 0.4–0.7 mm). Color pale green. Paired dorsal spines on either side of median line bearing secondary lateral setae.

Head: Similar to previous instar in outline and shape. Dense setae on clypeus, frons and vertex.

Thorax: Paired dorsal spines with secondary setae on dorsal edge, tips fuscous. All paired dorsal thoracic spines projecting anteriorly. Pro and mesothoracic legs similar in form and size, tibiae laterally compressed, dense setae on margins. Tibiae of metathoracic legs triangular in cross section, 1½ times length of pro and mesothoracic tibiae.

Abdomen: Dorsum of abdominal segments 1 and 2 with short, prominent



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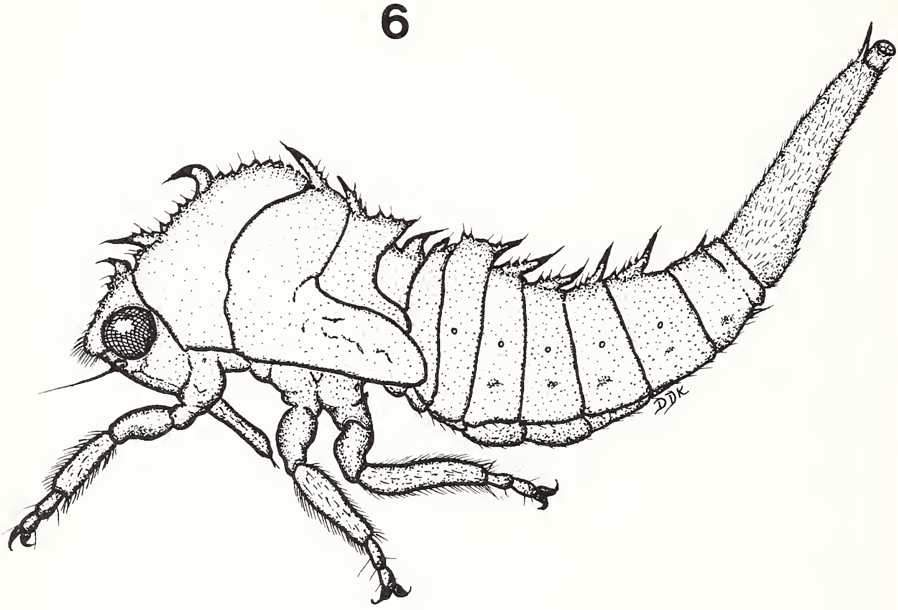

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Figs. 6, 7. 6. Lateral view of 4th instar nymph of *Acutalis tartarea* (Say). 7. Lateral view of 5th instar of *A. tartarea*.

setae. Dorsum of segments 3, 4, 5, 6, 7 and 8 with prominent posteriorly projecting spines, spines with secondary setae on dorsal margin. Abdomen triangular in cross section, folding along line of junction of the lateral and ventral plates. Segment 9 elongate, tapering to apex.

Third Instar (Fig. 5).—Outline and shape similar to previous instar except in size and caudal edge of the meso and metathoracic lateral plates developed into wing buds. Mean length 2.6 ± 0.10 mm (range: 2.0–2.8 mm), width 0.7 ± 0.05 mm (range: 0.5–0.8 mm). Color pale green. Paired dorsal spines on head, thorax and abdomen with tips black. Venter of abdomen concave.

Head: Frons densely covered with setae, caudal edge of clypeus forming a ridge between eyes.

Thorax: Similar to previous instar except wing buds apparent on meso and metathoracic segments. Mesothoracic wing buds covering ½ of metathoracic wing buds. Metathoracic wing buds covering ½ of 3rd abdominal segment.

Abdomen: Abdominal segments 1 and 2 covered by caudal edge of metathoracic plate. Venter of abdominal segments concave. Segment 9 elongate, tapering to apex.

Fourth Instar (Fig. 6).—Outline and shape similar to previous instar except in size. Mean length 3.3 ± 0.15 mm (range: 2.5–3.9 mm), width 0.9 ± 0.04 mm (range: 0.7–1.1 mm). Color pale green. Mesothoracic wing buds extending onto 3rd abdominal segment. Metathoracic wing buds well developed and covered by mesothoracic wing buds. Paired dorsal spines prominent, with black tips. Venter of abdomen strongly concave.

Head: Setae dense on clypeus and frons. Paired dorsal spines on vertex smaller than thoracic or abdominal dorsal spines.

Thorax: Prothoracic dorsal sclerite extending caudo-mesad over ½ of metathoracic dorsum between paired dorsal spines. Mesothoracic wing buds covering metathoracic wing buds and extending onto 3rd abdominal segment.

Abdomen: Venter of abdomen strongly concave. Segment 9 elongate, tapering to apex and subequal to the combined length of segments 2–8.

Fifth Instar (Fig. 7).—Outline and shape similar to previous instar except in size. Mean length 5.7 ± 0.21 mm (range: 3.3–7.7 mm), width 1.3 ± 0.10 mm (range 0.8–1.8 mm). Color pale green. Body setae dense. Paired dorsal spines on head, thorax and abdomen with prominent black tips. Venter of abdomen strongly concave.

Head: Setae dense on clypeus and frons. Paired dorsal spines on vertex ⅓ to ½ length of thoracic and abdominal dorsal spines.

Thorax: Prothoracic dorsal sclerite extending between paired dorsal spines of mesothorax. Mesothoracic wing buds covering metathoracic wing buds and extending caudally onto 3rd abdominal segment.

Abdomen: Venter strongly concave.

Taxonomy

In America, north of Mexico, the genus *Acutalis* historically has had three described species: *A. tartarea* (Say), *Acutalis semicrema* (Say) and *Acutalis inornata* (Ball). Differentiation of these three species was based upon coloration of the pronotum and pigmentation of the venation of the tegmen (Van Duzee 1908). *A. tartarea* was the darkest in coloration and this traditionally has been applied to specimens collected throughout the Northeast, North Central and West Central portions of North America. *A. semicrema,* originally described from Florida material, was not as darkly pigmented as *A. tartarea.* More recent distribution records show the range of *A. semicrema* to be very similar to that of *A. tartarea. A. inornata,* described by Ball (1905) from Florida, is entirely green in color with no black markings. Most distribution records of *A. inornata* have been from Florida. However, intensive collecting in more northern states has produced specimens that would be classified as *A. inornata* (Kopp and Yonke 1973).

As early as Matausch (1912) field observations were casting doubt upon the species status of *A. tartarea* and *A. semicrema.* His observations indicated that many of the females in his New Jersey collecting site were of the *A. semicrema* form while the males were of the *A. tartarea* form. This also was observed by the authors, who view this coloration pattern as a form of sexual dimorphism.

Caldwell (1949) studied the genitalia of the three described species of *Acutalis* and could not find distinctive differences. He treated these three forms as trinomials, *Acutalis tartarea tartarea* (Say), *Acutalis tartarea semicrema* (Say) and *Acutalis tartarea inornata* (Ball). From Caldwell's treatment it is apparent he used the trinomial to designate color varieties of the same species, not, as today, to denote subspecies.

We feel that Caldwell's treatment of these three species as one is entirely justified. We view *A. tartarea* as a single species that in the adult stage presents several different polymorphic color forms to the environment. Intensive collecting of local populations in Missouri and Florida has produced representatives of all three forms.

Field observations of populations in Florida offer another line of evidence for the acceptance of the single species with several color morphs. In Florida, where the three morphs can be most frequently encountered, mating between the forms has been observed from February to June. These matings in the natural habitat are strong evidence indicating a lack of reproductive isolation necessary for species consideration of each form. No infertility was observed in the laboratory studies in which 9 pairs of green and black forms were crossed. Of the 152 individuals produced, 40 of the green forms were found to be female, and 86 of the black-headed forms were males.

The following listed synonymy is presented for the species *Acutalis tartarea* (Say).

Micrutalis tartarea Say, 1830:242:1.
Micrutalis semicrea Say, 1830:242:2.
Acutalis anticonigra Fairmaire, 1846:498.
Tragopa brunnea Provancher, 1872:320.
Acutalis inornata Ball, 1905:119.
Acutalis tartarea semicrema Van Duzee, 1917:529.
Acutalis tartarea tartarea Severin, 1927:33.
Acutalis tartarea inornata Caldwell, 1949:498.
Acutalis tartarea semicrema Caldwell, 1949:498.

Discussion

A. tartarea has a broad range and presents a variety of color polymorphs within populations. Three of these polymorphs have been described as species, traditionally separated from each other by their colors and patterns of coloration. Matausch (1912) doubted the validity of species status for both *A. tartarea* and *A. semicrema* based on field observations in New Jersey. Caldwell's (1949) studies on the insect's genitalia indicated that there was a single species of *Acutalis* in America, north of Mexico, and he listed the polymorphs as varieties of *A. tartarea*.

Field observations by the present authors indicate that many populations had 2 or more polymorphs present which freely interbreed in nature, thus supporting the observations of Matausch (1912). Laboratory rearings were accomplished with several polymorphs and no abnormal infertility was observed.

We view *A. tartarea* as a single species with color polymorphs throughout its range. These morphs show different proportions in different geographic areas. The biological mechanism of expression of these polymorphs is not understood but may be a complex interrelationship of ecotypical color forms, temperature related color expression, sexual dimorphism, and/or a nymphal host plant relationship. Further autecological studies will be required to fully understand these forms.

Our observations on the life history of *A. tartarea* shows similarities to the life history of *M. malleifera* as observed by Simons (1962). These similarities are: mean incubation time of the eggs, mean development time of instars 1 to 3, presence of adults in the field year round in Florida, gregarious behavior of early instar nymphs, head down feeding stance of the nymphs

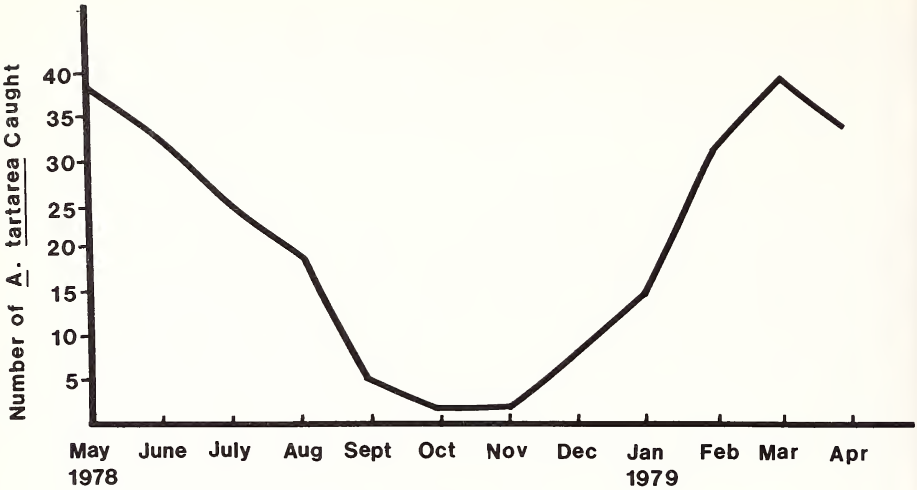

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Fig. 8. Monthly total numbers of adults and nymphs of *Acutalis tartarea* (Say) found on common ragweed.

and highest reproductive activity during the active growing seasons of their respective hosts.

A. tartarea has 5 nymphal instars with a total mean development time from egg to adult of about 50 days. This is about 25% longer than *M. malleifera*. Simons (1962) indicated *M. malleifera* had 4 nymphal instars, which is remarkably unusual since all other treehoppers, whose biology have been studies, have 5 nymphal instars. The difference may have been due to rearing hosts (Simons, personal communication).

In Florida populations of both *A. tartarea* and *M. malleifera* show fluctuation trends through the season. Both species are most active and reach highest populations during the warmest months. Lowest field populations of *M. malleifera* occur from October through April (Simons 1962). Populations of *A. tartarea* show rapid decreases during July, reaching a low during the months of August through November (Fig. 8). Seasonal population fluctuations of both species are related to the seasonal growth cycle of their host plants.

The favored field host of *A. tartarea* in Florida is common ragweed. Laboratory rearings on this host were quite successful. China aster was also used as a laboratory rearing host for *A. tartarea*. The species could be continuously reared on this host but individuals reared on it showed longer development time than those reared on common ragweed (see Table 1). It was also noted that adults of *A. tartarea* which had been reared form the egg stage on China aster, had a greater adult longevity than those reared on its native host plant.

Acknowledgment

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